TARGET SYSTEM AND METHOD
FOR ASCERTAINING TARGET IMPACT LOCATIONS OF A PROJECTILE
PROPELLED FROM A SOFT AIR TYPE FIREARM

1   **CROSS-REFERENCE TO RELATED APPLICATIONS**

2   This application claims priority from U.S. Provisional Patent Application Serial No.

3   60/421,768, entitled, "Target System and Method for Ascertaining Target Impact Locations

4   of a Projectile Propelled from a Soft Air Type Firearm," and filed October 29, 2002. The

5   disclosure of the above-mentioned provisional application is incorporated herein by reference

6   in its entirety.

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8   **BACKGROUND OF THE INVENTION**

9   1. Technical Field

10   The present invention pertains to target assemblies for firearm simulation, training

11   and gaming systems. In particular, the present invention pertains to a target assembly for use

12   with soft air type firearms to ascertain projectile impact locations thereon and transfer the

13   impact information to a computer system to visually indicate those impact locations and/or

14   interact with a gaming application. Alternatively, the target assembly may be utilized with a

15   display system to display score values for and/or an elapsed time between projectile impacts.

16   2. Discussion of the Related Art

17   Firearms are utilized for a variety of purposes, such as hunting, sporting competition,

18   law enforcement and military operations. The inherent danger associated with firearms

19   necessitates training and practice in order to minimize the risk of injury. However, special

20   facilities are required to facilitate practice of handling and shooting the firearm. These special

21   facilities basically confine projectiles propelled from the firearm within a prescribed space,

22   thereby preventing harm to the surrounding area. Accordingly, firearm trainees are required

23   to travel to the special facilities in order to participate in a training session, while the training

24   sessions themselves may become quite expensive since each session requires new live

25   ammunition for practicing handling and shooting of the firearm.

26   In recent years, a new class of sport/gaming firearm, known as soft-air guns, has been

1   added to the traditional line of spring and air-powered BB and pellet guns. Soft-air guns are

2   often styled in physical appearance and operation as their lethal firearm counterparts.

3   However, projectiles fired from soft-air guns are fired with insufficient force to impart

4   significant destructive force to a target, whether live or inanimate. Given the low energy of

5   the projectile fired, soft-air guns are unlikely to cause serious injury, even if inadvertently

6   mishandled. Furthermore, soft-air guns are low noise and ideal for use indoors and in

7   residential neighborhoods in which target shooting with a conventional firearm would be

8   unsafe and/or prohibited. For this reason, soft-air guns are popular for recreational target

9   shooting and for firearm proficiency training.

10   Several styles of conventional targets are currently marketed for use with soft-air

11   guns. One such target holds a replaceable paper target that the soft-air projectile is capable of

12   penetrating. Another conventional target includes a sticky, impact absorbing material that

13   catches and holds a soft-air projectile on impact. Yet another conventional target holds

14   several plastic and/or paper saucer style targets that react to the impact of a fired projectile.

15   Some conventional targets include a retrieval bin that facilitates the collection and reuse of

16   fired projectiles.

17   The above-described systems suffer from several disadvantages. For example,

18   conventional target systems for use with soft-air guns provide a shooter only static targets

19   that must be manually reset and/or replaced to vary the target presented to the shooter. Such

20   conventional target systems cannot automatically evaluate a shooter's score and/or track

21   progress over time, cannot interface with popular electronic gaming devices capable of

22   presenting a varied array of automatically changing targets in a variety of gaming

23   environments, and provide no manner by which shooters can interact with and compete

24   interactively with shooters at remote locations.

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26   **OBJECTS AND SUMMARY OF THE INVENTION**

27   Accordingly, it is an object of the present invention to provide automated scoring for

28   target shooting performed with soft-air and other low force guns.

29   It is another object of the present invention to provide an automated scoring capability

30   for use with traditional physical, paper and computer generated targets.

31   Yet another object of the present invention is to support integrated use of soft air and

1   other low force guns with electronic gaming systems and/or devices to present a variety of

2   automatically changing targets under a variety of gaming scenarios.

3   Still another object of the present invention is to evaluate a shooter score and track

4   shooter progress and accuracy over time.

5   A further object of the present invention is to support networked shooting

6   competitions between local and remote shooters using non-penetrating projectile firing guns.

7   The aforesaid objects are achieved individually and/or in combination, and it is not

8   intended that the present invention be construed as requiring two or more of the objects to be

9   combined unless expressly required by the claims attached hereto.

10   According to the present invention, a target assembly for use with soft-air or other

11 low force firearms projecting low-energy, non-penetrating, projectiles includes a transparent

12 pressure sensitive impact detection device.   The detection device typically overlays an

13 intended target (e.g., paper or other target, monitor for virtual targets, etc.) and determines

14 projectile impact locations thereon.   The impact information is transferred to a computer

15 system to display the projectile impact location on an image of the target and/or interact with

16 a gaming application.   The detection device permits the soft air firearm to be utilized with

17 various virtual targets (e.g., generated by software gaming, competition or training

18 applications, etc.) and with a variety of paper or other targets. The detection device may be

19 employed with computer systems connected over a network to facilitate joint training,

20 gaming or competition sessions.   Alternatively, the target assembly may transfer the impact

21 information to a display system to display score values for and/or an elapsed time between

22 the projectile impacts.

23   The above and still further objects, features and advantages of the present invention

24 will become apparent upon consideration of the following detailed description of specific

25 embodiments thereof, particularly when taken in conjunction with the accompanying

26 drawings wherein like reference numerals in the various figures are utilized to designate like

27 components.

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29   **BRIEF DESCRIPTION OF THE DRAWINGS**

30   Fig. 1A is a view in perspective of a target assembly for a soft air type firearm

31 mounted over a suspended target and coupled to a computer system for displaying projectile

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1 impact locations on the target.

2 Fig. 1B is a view in perspective of the target assembly of Fig. 1A mounted over a

3 display and coupled to a computer system for enabling the firearm to be utilized with virtual

4 targets according to the present invention.

5 Fig. 2 is a view in elevation of the target assembly of Figs. 1A and 1B.

6 Fig. 3 is a view in elevation and partial section of the target assembly of Fig. 2 with a

7 soft air type projectile impacting a target assembly surface.

8 Fig. 4 is an electrical schematic diagram of an exemplary control circuit for the target

9 assembly of Fig. 2.

10 Fig. 5 is a procedural flowchart illustrating the manner in which the target assembly

11 determines projectile impact locations thereon according to the present invention.

12 Fig. 6 is a view in perspective of the target assembly of Fig. 1A mounted over a target

13 and coupled to a display system according to an alternative embodiment of the present

14 invention.

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16 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

17 A target assembly 100 according to the present invention coupled to a computer

18 system is illustrated in Fig. 1A. Initially, a projectile 103 (e.g., BB, pellet, paintball, etc.) is

19 propelled from a soft air type firearm 101 (e.g., a pistol, rifle, hand-gun or other firearm

20 employing mechanical, electrical and/or compressed fluids to propel a projectile with

21 significantly reduced energy compared to that of an actual firearm) toward target assembly

22 100 placed proximate a target 104 (e.g., silhouette, bulls eye, etc.). The projectile impact

23 alters the electrical properties of the target assembly, thereby enabling determination of the

24 point of impact. The impact information is transferred to a computer system 108 to facilitate

25 display of the projectile impact on an image of the target. Specifically, target assembly 100

26 includes a transparent, pressure sensitive, impact detection device 102 and control circuitry

27 118 (Fig. 2). The detection device basically serves as a window and is preferably placed over

28 a conventional paper or other target 104 suspended from a supporting structure (e.g., wall,

29 stand, etc.) with the target visible to a user through the detection device. However, detection

30 device 102 may alternatively be opaque or translucent, where paper or other target 104 is

31 placed in front of the detection device surface for target visibility and to enable a projectile to

1   impart force to the detection device upon striking the target.   Detection device 102 is

2   connected to circuitry 118 via a cable 106, while the circuitry is connected to computer

3   system 108 via a connector cable 120 (Fig. 2).   The control circuitry monitors the electrical

4   properties of detection device 102 to determine projectile impact locations thereon for

5   transference to the computer system as described below.   The computer system utilizes the

6   projectile impact information for training, gaming and/or competition applications.   The soft

7   air firearm may be any weapon that propels a low-energy, non-penetrating, projectile (e.g.,

8   spring, compressed-fluid, soft-air, BB gun, pellet gun, paintball gun, etc.).

9   Computer system 108 is typically implemented by a conventional IBM-compatible or

10   other type of personal computer (e.g., laptop, notebook, desk top, mini-tower, Apple

11   MacIntosh, palm pilot, etc.) preferably equipped with a monitor 112, a base 110 (e.g.,

12   including the processor, memories, and internal or external communication devices or

13   modems), a keyboard 114 and a mouse 116.   The mouse is preferably implemented by a

14   conventional desktop mouse for competition, gaming and/or training applications.   The

15   computer system may include various software to process impact information received from

16   target assembly 100 for competition, gaming and/or training applications.   For example,

17   competition and/or training software may display projectile impact locations on a target

18   image and other information (e.g., scores, statistics, groupings, etc.) related to use of firearm

19   101.   The manner in which computer system 108 processes the impact information and

20   displays impact locations and other information is substantially similar to the manner

21   disclosed in published U.S. Patent Application Publication No.: 2002/0012898, entitled

22   "Firearm Simulation and Gaming System and Method for Operatively Interconnecting a

23   Firearm Peripheral to a Computer System" and published January 31, 2002; and U.S. Patent

24   No. 6,616,452 (Clark et al).   The disclosures of the aforementioned patent and patent

25   application publication are incorporated herein by reference in their entireties.   Further,

26   gaming software may include any computer games, where the impact information is applied

27   to a computer game to enable a user to utilize firearm 101 within that game.   In other words,

28   the target assembly enables firearm 101 to serve as a peripheral for the computer game.

29   Computer system 108 may further include networking hardware and software to

30   communicate with a host server and/or remote computer systems at different locations

31   employing a target assembly 100 to provide joint training, competition or gaming sessions as

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1   described below. The computer system may utilize any of the major platforms, such as
2   Windows, Linux, Macintosh, Unix or OS2. Further, the computer system includes
3   components (e.g., processor, disk storage or hard drive, etc.) having sufficient processing and
4   storage capabilities to effectively execute the software.
5   The detection device may be utilized with any type of target illustration or object to
6   determine projectile impact locations thereon as described above. Alternatively, the detection
7   device may be utilized with a monitor to determine impact locations on virtual targets or
8   icons as illustrated in Fig. 1B. Specifically, computer system 108, substantially similar to the
9   computer system described above, produces a virtual target 104 (e.g., bulls eye, etc.) for
10 display on monitor 112. The target may be generated by a training, competition or gaming
11 software application executing on the computer system. The detection device is substantially
12 transparent and placed over monitor 112 with the virtual target visible to a user through that
13 device. The user fires projectile 103 from firearm 101 toward the detection device and virtual
14 target. Detection device 102 determines the projectile impact location thereon and transfers
15 this information to computer system 108. The computer system processes the impact
16 information to determine an impact location relative to the virtual target. The computer
17 system may display the impact locations and other information when conducting a training or
18 competition session as described above. In the case of a gaming application, the software
19 creating the gaming scenario utilizes the impact information to adjust the scenario or other
20 conditions based on a target impact or miss. In other words, the detection device enables the
21 soft air firearm to directly interact or interface with the gaming application. Computer
22 system 108 may include a foot-actuated mouse (not shown) to enable a user to control the
23 firearm and enter data for, or navigate through, the operating system, gaming, competition or
24 training application software.
25   The target assembly may be utilized with various virtual targets displayed by monitor
26 112, such as those dynamically updated based upon projectile impact events. Further, the
27 target assembly may be utilized with a wide range of electronically stored and/or animated
28 targets that produce various gaming or training scenarios. For example, the targets may be
29 associated with a dynamic story-line that changes depending upon the accuracy of the user's
30 shooting (e.g., a computer game, etc.).
31   Referring to Fig. 2, target assembly 100 includes detection device 102 and control

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1   circuitry 118 preferably disposed within a housing 119. Alternatively, the control circuitry

2   may be mounted to and/or disposed behind the detection device at any suitable location.

3   Detection device 102 is connected by a cable 106 to control circuitry 118. The control

4   circuitry monitors the electrical characteristics of detection device 102 to determine projectile

5   impact locations thereon as described below. Control circuitry 118 communicates with

6   computer system 108 via a connector cable 120. The connector cable typically includes a

7   conventional Universal Serial Bus (USB) type connector and transfers projectile impact

8   information to computer system 108. The connector is typically compatible with USB

9   Specification, Version 2.0 and/or USB HID Specification, Version 1.1, while the connection

10   may support Low-Speed USB device addressing. However, any standard or proprietary

11   communications interface can be used (e.g., serial port connection, parallel port connection,

12   USB connection, etc.). For example, connector cable 120 may include connectors for a serial

13   communications port, parallel communications port, game port or other standard physical

14   communications port. The control circuitry may be modified to support these types of

15   connections. The control circuitry may alternatively be disposed on a standard computer

16   interface card that is inserted directly into computer system 108.

17   Detection device 102 includes a plurality of layers as illustrated in Fig. 3.

18   Specifically, the detection device includes an impact layer 144, a cushion layer 146 and a

19   sensor layer 148. The impact layer forms the outer surface of the detection device and

20   receives the initial impact of the projectile to protect the underlying device layers. Cushion

21   layer 146 is disposed between the impact and sensor layers and further absorbs the projectile

22   impact forces. Sensor layer 148 is constructed of a material including electrical resistance

23   properties that are altered in response to a projectile impact. The detection device layers may

24   be constructed of any conventional or other composite and generally resilient materials,

25   preferably those utilized for conventional touch sensitive products (e.g., Programmable

26   Digital Assistants (PDA), etc.). The layers may be of any desired thickness sufficient to

27   protect the sensor layer, while enabling the sensor layer to detect soft air type projectiles

28   (e.g., BB, pellet, paintball, etc.) of any size or weight. By way of example only, the detection

29   device has a thickness of approximately 4.5 millimeters.

30   The control circuitry basically monitors the resistance of the sensor layer at specific

31   points or locations 700 (Fig. 4) to determine the occurrence and location of a projectile

1   impact. In particular, a voltage is initially applied to the sensor layer to enable measurement

2   of resistance at those points as described below. The resistance at each location 700 is

3   substantially similar with respect to a reference resistance in the absence of a projectile

4   impact. However, in response to a projectile impact, each location resistance independently

5   varies from the reference resistance in accordance with the proximity of the projectile impact

6   to that location as described below. In particular, the impact of a soft air projectile on the

7   surface of impact layer 144 results in a sudden and temporary deformation of the impact layer

8   that presses the impact layer against cushion layer 146. This, in turn, deforms and displaces

9   the cushion layer toward sensor layer 148 (e.g., as shown by the arrows in Fig. 3). Basically,

10   cushion layer 146 is pressed against the sensor layer, thereby applying the projectile impact

11   force to the sensor layer in a reduced state to deform the sensor layer and adjust the sensor

12   layer electrical resistance. The detection device layers are typically constructed of resilient

13   materials, thereby enabling the layers to enter a deformed state and return to their original

14   state after a projectile impact. In other words, the sensor layer is constructed of a flexible,

15   resilient conductive material. When the sensor layer is deformed by localized pressure (e.g.,

16   a projectile impact), the electrical resistance of the material is altered. The changes in the

17   resistive properties of sensor layer 148 at the specific locations are monitored by the control

18   circuitry to determine projectile impact location coordinates. In this manner, detection device

19   102 controllably receives the force of impact of a projectile fired from a soft air type firearm,

20   while allowing sufficient force to be conveyed to sensor layer 148 to determine the point of

21   impact of projectile 103. The detection device may alternatively employ materials or target

22   structures including any electrical or pressure sensitive properties that are alterable in

23   response to a projectile impact (e.g., capacitance, magnetic field, etc.) to determine the

24   impact location thereon.

25   An exemplary control circuit for the target assembly is illustrated in Fig. 4.

26   Specifically, control circuitry 118 includes a target sensor monitor 704, a target controller

27   706 with an accompanying crystal 708, a memory 710 and a cable connector 712 for

28   connection to computer system 108 via cable 120 (Fig. 2). The target sensor monitor is

29   preferably in the form of an application specific integrated circuit (ASIC) and samples the

30   electrical properties of sensor layer 148. The target sensor monitor is coupled to detection

31   device 102 and target controller 706. Circuitry 714 provides appropriate power signals to

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1   target sensor monitor 704 and generally includes a voltage source (e.g., Vcc) and a series of

2   capacitors (e.g., generally three capacitors each with a capacitance of 0.1 microfarads)

3   arranged in parallel between the voltage source and ground. The voltage source is further

4   applied to detection device 102 to enable the device resistive properties to be measured as

5   described below.

6   The target controller is typically in the form of an integrated circuit and controls the

7   target sensor monitor. The target controller is coupled to memory 710 and connector 712 and

8   is basically a processor with a clock derived from crystal 708. The crystal typically provides

9   a 6MHz signal, but may provide any type of signal at any desired frequency. The target

10   controller controls target sensor monitor 704 to sample particular detection device points and

11   determine impact location coordinates, and further processes these coordinates to account for

12   various conditions (e.g., calibrations relating to temperature and other conditions, etc.). The

13   resulting coordinates are transferred to the computer system via connector 712. Circuitry 716

14   provides the appropriate power signals to target controller 706 and generally includes a

15   voltage source (e.g., Vcc) and a pair of capacitors (e.g., a 0.1 microfarad capacitor and a 10

16   microfarad capacitor) arranged in parallel between the voltage source and ground. In

17   addition, a resistor (e.g., a 1.3 K Ohm resistor) is utilized to regulate voltage along a

18   connection between the target controller and connector 712.

19   Memory 710 is preferably in the form of an electrically erasable programmable read

20   only memory (EEPROM) and stores software for the target controller. Circuitry 718

21   provides appropriate power signals to memory 710 and generally includes a voltage source

22   (e.g., Vcc) and a capacitor (e.g., a 1.0 microfarad capacitor) disposed between that voltage

23   source and ground. The connector is in the form of a conventional USB type connector and

24   receives the processed impact location coordinates for transference to the computer system,

25   preferably in accordance with the aforementioned USB specifications. A voltage source

26   (e.g., Vcc) is coupled to the connector to provide appropriate power signals.

27   Control circuitry 118 monitors detection device 102 to identify the occurrence and

28   location of a projectile impact on that device. Initially, a voltage is typically applied (e.g.,

29   from the voltage source of circuitry 714 or from target sensor monitor 704) across sensor

30   layer 148 of detection device 102, while the target sensor monitor measures current at

31   specific points 700 of the sensor layer (e.g., shown, by way of illustration only, as resistor

1   symbols in Fig. 4). A projectile impact on the detection device results in a deformation of the

2   sensor layer resilient conductive material and a detectable change in sensor layer resistance at

3   monitored points 700. The resistance change at each point is determined based upon the

4   measured current.

5   Target controller 706 controls target sensor monitor 704 to sample analog current

6   values from points 700 (e.g., X+, Y+, X-, Y-). Since the duration of a soft air projectile

7   impact is relatively brief, the target sensor monitor samples points 700 at a high rate

8   compared with traditional touch sensitive devices (e.g., PDA, etc.) that detect pressure

9   originating from the touch of a finger or stylus. The target sensor monitor digitizes the

10   current measurements and determines the coordinates (e.g., Cartesian (X and Y) coordinates)

11   of the projectile point of impact on the detection device. These coordinates may include a

12   resolution on the order of twelve bits (e.g., for each of the X and Y axes). The determined

13   coordinates are passed to target controller 706 for further processing to account for various

14   conditions (e.g., calibrations relating to temperature and other conditions, etc.). The target

15   controller transfers the processed projectile impact information to computer system 108 via

16   connector 712 and corresponding USB cable 120. The exemplary control circuitry is similar

17   to that employed in conventional PDAs or other touch sensitive devices, except that the

18   control circuitry is designed for higher response time to detect and process the projectile

19   impacts in a short time interval.

20   In order for the computer system to utilize the projectile impact information received

21   from control circuitry 118, the target assembly needs to be correlated with the associated

22   target and the computer system. Initially, the detection device is physically aligned with the

23   target via placement of the detection device proximate monitor 112 for virtual targets, or

24   proximate a printed target or other object. In order to correlate the detection device

25   coordinate space with the target space, the detection device is calibrated by a user touching or

26   otherwise applying pressure (e.g., via a projectile from firearm 101) to the detection device at

27   a location corresponding to the center of the target in response to a prompt by the computer

28   system. The computer system may initiate a calibration prior to commencing a training,

29   competition or gaming session or the user may command the computer system to enter a

30   calibration mode at any time prior, during or after the session. The target assembly

31   determines the calibration location coordinates in substantially the same manner employed

1   for projectile impacts for transference to the computer system. This information is utilized by
2   the computer system to process impact location coordinates received from the target
3   assembly. In other words, the computer system adjusts the coordinates received from the
4   target assembly to reflect a position relative to the user-specified target center (e.g., the target
5   center coordinates from the calibration may be applied in the form of an offset to impact
6   location coordinates).

7   The resulting adjusted coordinates are translated to corresponding coordinates in the
8   particular application space (e.g., a target image space for displaying impact locations, a
9   virtual or monitor space for virtual targets, etc.). In other words, the resulting coordinates are
10 translated to indicate a projectile impact location on a virtual target in the virtual target or
11 monitor space, or on an image of the actual target in the image space. The calibration may
12 alternatively utilize any quantity of points at any desired detection device or target locations,
13 where the points define the target area on the detection device and correlate the detection
14 device with the computer system.

15   The manner in which the target assembly samples detection device 102 and
16 determines the occurrence and location of projectile impacts is illustrated in Fig. 5. Initially,
17 the target assembly is positioned with respect to a target and connected to computer system
18 108 (Figs. 1A – 1B). A voltage is applied across the sensor layer of the impact detection
19 device at step 804 to enable measurement of sensor layer resistive properties. An initial
20 current measurement at each of points 700 (Fig. 4) is ascertained and utilized to indicate a
21 reference resistance for each point and to detect resistance changes of those points indicating
22 projectile impacts. Specifically, the target sensor monitor samples analog current signals
23 from sensor layer locations 700 at step 806 in response to controls from target controller 706.
24 The sampled analog values are digitized and processed by the target sensor monitor to
25 determine the occurrence of a projectile impact. This is accomplished by processing the
26 digitized current values to determine the occurrence of a change in resistance at points 700
27 indicating a projectile impact. Basically, the control circuitry monitors locations 700 on the
28 sensor layer, each preferably within a different quadrant. The target sensor monitor receives
29 current signals indicating the resistance of each location. A projectile impact produces a
30 resistance change for each location that may be detected based on the measured current (e.g.,
31 the resistance is proportional to the applied voltage divided by the measured location current).

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1   The resistance at each location is compared to the corresponding reference resistance value

2   for that location to determine the resistance change. The amount of change for each

3   individual location or combination of locations is compared to a threshold to determine the

4   occurrence of a projectile impact at step 816. The threshold is basically utilized to prevent

5   false hit indications in response to resistance changes occurring due to conditions other than a

6   projectile impact (e.g., temperature, etc.). The threshold may be set to any desired value and

7   adjusts the sensitivity of the target assembly to projectile impacts and ambient conditions.

8   If a projectile impact occurred (e.g., the resistance change of individual and/or a

9   combination of locations exceeds the threshold), the projectile impact location is determined

10   at step 822 by the target sensor monitor. In particular, the target sensor monitor utilizes the

11   resistance deviation at each location 700 to determine the projectile impact location. For

12   example, the resistance deviations may serve as weights and be applied to corresponding

13   location coordinates to produce a weighted average indicating the coordinates of the

14   projectile impact location. Alternatively, ratios or differences of resistance deviations

15   between two or more points may be applied to corresponding distances between the points to

16   determine an impact location relative to those points. Generally, a substantially equal

17   resistance deviation at each of the locations indicates a projectile impact location equidistant

18   from each of the points or at the detection device center, while a greater deviation at one or

19   more locations indicates the projectile impact location to be nearest those locations. Thus,

20   the target sensor monitor combines the resistance deviations of the locations with the

21   coordinates of or distances between those locations to determine the projectile impact

22   location. The determined coordinates are transferred to and processed by the target controller

23   to account for various conditions (e.g., calibrations relating to temperature or other

24   conditions, etc.).

25   The processed coordinates are transmitted from the target controller to computer

26   system 108 at step 824. The computer system processes the received coordinates to account

27   for the target assembly calibration and may translate the resulting coordinates to

28   corresponding coordinates within the monitor or virtual target space for virtual targets to

29   indicate projectile impacts on those virtual targets. Alternatively, the computer system may

30   translate the resulting coordinates to corresponding coordinates within an image of a paper or

31   other target to display projectile impact locations on the target image corresponding to the

1   actual impact locations on the target. The translations are basically accomplished by

2   correlating the resulting coordinate units (e.g., corresponding to the detection device area)

3   with a quantity of pixels within a given measurement unit (e.g., corresponding to the monitor

4   or virtual target or the target image). The translations are typically accomplished in the

5   manners described in the aforementioned patent and patent application publication.

6   If a projectile impact has not occurred as determined at step 816, or impact

7   information has been transferred to the computer system at step 824, additional samples are

8   obtained at step 806 and the process is repeated until the computer and/or target assembly is

9   powered down as determined at step 826.

10   The target assembly may be utilized with various systems for training, competition

11   and gaming applications. Several participants can engage in a competition, training or

12   gaming session from remote locations, thereby eliminating the travel and arrangements

13   normally associated with such events. For example, one or more computer systems 108 with

14   target assemblies 100 may be interconnected via a Local Area Network (LAN), Wide Area

15   Network (WAN) and/or the Internet. Each computer system is equipped with communication

16   hardware (e.g., a modem or network card) and software that allow each system to establish

17   communications with similarly equipped systems, either directly, or via a network host

18   server. The manner in which the systems may communicate and function in a networked

19   environment to provide joint training, gaming or competitions is substantially similar to that

20   described in U.S. Patent No. 6,322,365 (Shechter et al), the disclosure of which is

21   incorporated herein by reference in its entirety. Further, the target assembly and/or computer

22   system may detect the user distance from the target assembly via any range detection devices

23   (e.g., ultrasound, transmitter and receiver, etc.) coupled to the firearm, computer system

24   and/or target assembly in substantially the same manner described in the aforementioned

25   Shechter et al patent. This ensures that a user is an appropriate distance from the target

26   assembly for a particular training, competition or gaming application.

27   A target assembly 100 coupled to a display system according to an alternative

28   embodiment of the present invention is illustrated in Fig. 6. Specifically, target assembly 100

29   is substantially similar to the target assembly described above, except that the target assembly

30   is coupled to a display system 105 including a processor 111. Projectile 103 is propelled

31   from soft air type firearm 101 toward target assembly 100 placed proximate a target 104 (e.g.,

1   bulls eye, etc.) as described above. The projectile impact alters the electrical properties of the

2   target assembly, thereby enabling determination of the point of impact as described above.

3   The impact information is transferred to the display system processor to facilitate display of

4   an impact score and an elapsed time. Thus, the alternative embodiment basically employs a

5   display system with a processor to process the impact location coordinates received from the

6   target assembly and display information to enable use of the target assembly without the

7   external personal or other computer system described above.

8   Target assembly 100 includes transparent, pressure sensitive, impact detection device

9   102 and control circuitry 118 (Fig. 2), each as described above. The detection device

10   basically serves as a window and is preferably placed over a conventional paper or other

11   target 104 suspended from a supporting structure (e.g., wall, stand, etc.) with the target

12   visible to a user through the detection device.   However, detection device 102 may

13   alternatively be opaque or translucent, where paper or other target 104 is placed in front of

14   the detection device surface for target visibility and to enable a projectile to impart force to

15   the detection device upon striking the target. Detection device 102 is connected to circuitry

16   118 via cable 106, while the control circuitry is connected to display system 105 via

17   connector cable 120 (Fig. 2).   The control circuitry monitors the electrical properties of

18   detection device 102 to determine projectile impact locations thereon for transference to the

19   display system in substantially the same manner described above. The display system utilizes

20   the projectile impact information to determine a score for and an elapsed time between

21   projectile impacts with respect to training, gaming and/or competition applications as

22   described below.

23   Display system 105 includes a score display 107 to display a cumulative and/or

24   individual impact score, a time display 109 to display an elapsed time between successive

25   projectile impacts, processor 111 and a reset button or switch 115. The display system is

26   typically suspended from a support structure (e.g., a wall, table, stand, etc.), preferably near

27   the detection device and visible to a user, and may receive power (not shown) from a

28   conventional wall outlet jack or other power source (e.g., batteries, etc.). The score display is

29   typically disposed above the time display with the reset switch placed between those

30   displays; however, the displays and reset switch may be arranged in any fashion. Displays

31   107, 109 may be of any shape or size, and may be implemented by any types of conventional

1   or other displays (e.g., LED, LCD, flat screen or other monitor, etc.). The displays typically

2   display an impact score and elapsed time, but may be utilized to display any information.

3   The display system is coupled to control circuitry 118 via connector cable 120 to

4   enable processor 111 to receive projectile impact information, typically in the form of impact

5   location coordinates as described above. The control circuitry may be disposed at any

6   suitable location, but is preferably mounted to or within the detection device or display

7   system. The communication between the display system and control circuitry is substantially

8   similar to the communications described above between the control circuitry and computer

9   system 108. The processor is typically implemented by a conventional or other

10   microprocessor (e.g., those available from Intel, Motorola, etc.) and processes the impact

11   information, under software control, to determine an individual or cumulative impact score

12   and an elapsed time between successive projectile impacts on the detection device. The

13   processor may further include networking hardware and software to communicate with a host

14   server and/or remote processors or computer systems at different locations to provide joint

15   training, competition or gaming sessions in the manner described above, while the target

16   assembly and/or display system may detect the user distance from the target assembly via any

17   range detection devices (e.g., ultrasound, transmitter and receiver, etc.) coupled to the

18   firearm, display system and/or target assembly in substantially the same manner described

19   above. Moreover, the processor may be implemented by, coupled to, or include any

20   components (e.g., processor, memories, etc.) having sufficient processing and storage

21   capabilities to effectively execute the software.

22   The display system processor receives the impact location coordinates from the target

23   assembly and determines the individual and/or total impact score and elapsed time for

24   display. In particular, the control circuitry determines the location or coordinates of a

25   projectile impact on the detection device as described above. The processor receives the

26   coordinates and determines a score for the projectile impact based on the location of that

27   impact on the detection device. Basically, target 104 (e.g., bulls eye, silhouette, etc.) is

28   partitioned into zones with each zone associated with a score value. The processor includes

29   information relating to the score value for each target zone. When the processor receives

30   impact information from the control circuitry, the location of the impact on the detection

31   device and/or zone containing the impact location is determined and the appropriate score

1   value is retrieved. The score values for each impact may be accumulated to produce a total

2   score. The processor may display an individual impact and/or total score on score display

3   107. For example, the processor may display the individual score and total score in

4   alternating fashion (e.g., display the individual score followed by the total score on display

5   107, etc.). The manner in which the processor processes the impact information to determine

6   individual and total impact scores may be substantially similar to the manner disclosed in the

7   aforementioned Clark et al patent and patent application publication.

8   The processor further determines an elapsed time between successive projectile

9   impacts for display on time display 109. The processor basically employs a counter to

10   measure the elapsed time between projectile impacts. Each counter increment corresponds to

11   a particular time interval (e.g., a particular quantity of processor clocks, any desired interval,

12   etc.), where the counter is incremented to indicate the quantity of time intervals that have

13   elapsed. The count accumulated by the counter between successive projectile impacts is

14   determined and converted to appropriate time units (e.g., minutes, seconds, etc.) for display

15   on time display 109.

16   In order to correlate the detection device coordinate space with the target space, the

17   detection device is calibrated by a user touching or otherwise applying pressure (e.g., via a

18   projectile from firearm 101) to the detection device at a location corresponding to the center

19   of the target as described above in response to a prompt by the display system (e.g., indicator

20   on the display system). The calibration is typically performed after a target assembly reset

21   occurs (e.g., via actuation of reset switch 115) or in response to system power-up. The reset

22   switch may be implemented by any conventional or other switch or button and basically

23   facilitates a reset of the target assembly (e.g., processor, displays, etc.). However, the

24   processor may initiate a calibration prior to commencing a training, competition or gaming

25   session or the user may command the processor to enter a calibration mode at any time prior,

26   during or after the session via the reset switch or other controls (not shown). The control

27   circuitry determines the calibration location coordinates in substantially the same manner

28   described above for transference to the processor. This information is utilized by the

29   processor to process impact location coordinates received from the control circuitry as

30   described above. In other words, the processor adjusts the coordinates received from the

31   control circuitry to reflect a position relative to the user-specified target center (e.g., the target

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1   center coordinates from the calibration may be applied in the form of an offset to impact

2   location coordinates).

3   It will be appreciated that the embodiments described above and illustrated in the

4   drawings represent only a few of the many ways of implementing a target system and method

5   for ascertaining target impact locations of a projectile propelled from a soft air type firearm.

6   The target assembly may be of any shape or size, and may be utilized with any type of

7   soft air type or other reduced power mock or actual firearm propelling non-penetrating

8   projectiles (e.g., compressed fluid firearms, mechanical firearms, electrical firearms, toy

9   firearms, projectile propelling devices that may or may not be in the form of a firearm, etc.)

10   of any size, shape or weight. The target assembly may be utilized with any type of computer

11   or processing system that can process the impact location information, and may be utilized

12   for any type of application (e.g., training, gaming, competition, simulation, etc.). The target

13   assembly may receive power from any suitable source (e.g., the computer or display system,

14   batteries, common wall outlet jack, etc.). The target assembly may detect impact locations

15   from any types of projectiles that are of any shape, size or weight (e.g., BB, pellet, paintball,

16   etc.) and constructed of any types of materials (e.g., plastic, metal, etc.). The target assembly

17   may be utilized with any type of virtual or actual target (e.g., paper or illustration, target

18   object, monitor or other display, etc.). The target assembly may be constructed of or include

19   dye resistant materials for use with dye or other material filled projectiles (e.g., paintballs,

20   etc.). In this case, the target assembly is sensitive to the initial impact of the projectile, and

21   does not respond to the material fill of the projectile impacting the target assembly (e.g., by

22   setting the threshold to an appropriate value, etc.).

23   The detection device may be of any shape or size and may include any quantity of

24   layers arranged in any fashion, constructed of any suitable materials and having any desired

25   thickness. The detection device may be transparent, translucent or opaque or include any

26   degrees thereof. The detection device may be placed in front of (e.g., generally when

27   transparent) or behind the target (e.g., when transparent, translucent or opaque) at any desired

28   orientation or angle. The detection device may alternatively employ materials or target

29   structures including any electrical or pressure sensitive properties that are alterable in

30   response to a projectile impact (e.g., capacitance, magnetic field, etc.) to determine the

31   impact location thereon. The detection device and display system may be mounted proximate

1   or near the target via any conventional or other fasteners and securing techniques (e.g.,
2   mountable frame, brackets, hook and loop fasteners, hooks, etc.).

3   The control circuitry may be implemented by any conventional or other components
4   (e.g., circuitry, chips, processors, gates, PGA, etc.) performing the functions described above.
5   The target sensor monitor and target controller may be implemented by any conventional or
6   other processor or circuitry. The target controller may include any type of crystal or
7   oscillator to provide a signal at any desired frequency. Further, the target sensor monitor may
8   sample the detection device at any desired sampling rate sufficient to detect a projectile
9   impact. The control circuitry may be external of the computer system or be placed on a card
10   for insertion into the computer system. The control circuitry, detection device, and computer
11   or display systems may be interconnected via any conventional or other communications
12   medium (e.g., cables, wireless, etc.). The control circuitry may be mounted to the detection
13   device or display system or be placed at any other location. The housing may be of any
14   shape or size sufficient to contain the control circuitry. The control circuitry may
15   communicate with the computer system or display system via any conventional or other port
16   or interface (e.g., serial port, parallel port, USB port, COM port, etc.), while the connector
17   may be implemented by any conventional or other connector and support any type of
18   connection to a computer or processing system. The memory may be implemented by any
19   type of conventional or other storage device and may contain any desired information.

20   The target assembly may sample any quantity of points on the detection device at any
21   desired locations. Any quantity of resistance deviations may be combined in any manner
22   (e.g., accumulated, weighted average, etc.) for comparison to the threshold for detecting a
23   projectile impact. The threshold may be of any quantity (e.g., a threshold for one or more
24   locations, etc.) and may be set to any desired value to adjust target assembly sensitivity. The
25   reference values may be sampled at any time prior, during or after a session at any desired
26   intervals. The resistance deviations may be measured in any desired fashion (e.g., applying
27   current and measuring voltage, applying voltage and measuring current, etc.), while the
28   impact location may be derived by utilizing the sampled values (e.g., resistance, current or
29   voltage) in the manner described above. The target sensor monitor may measure the current
30   or other properties and provide the coordinates with any desired resolution (e.g., in any
31   quantity of bits). The impact location may be derived from the resistance or other property

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1   deviations in any conventional or other manner (e.g., weighted average, etc.). The resistance

2   deviations may be weighted in any desired fashion for application to the point coordinates or

3   distances. Any suitable type of voltage or voltage level may be applied to the detection

4   device to measure the resistance or other properties (e.g., AC, DC, etc.). Preferably, the

5   applied voltage is in the range of 3 – 12V DC. The target controller may apply adjustments

6   to the impact location coordinates in any desired fashion and for any desired conditions (e.g.,

7   temperature, detection device configuration, etc.).

8   The calibration may be accomplished by a user identifying the center of the target to

9   the detection device in any desired manner (e.g., touching the point, firing a projectile, etc.).

10   The calibration may utilize any quantity of points at any desired locations on the detection

11   device to define a target area or location to the computer, processing or display system. The

12   calibration mode may be entered at any time prior, during or after a session and may be

13   initiated by a user or the computer, processing or display system.

14   The computer or display system may connect to any type of network to accommodate

15   plural users for training, competition or gaming activities. Plural target assemblies may be

16   connected to a computer system with plural monitors and/or alternative display devices or to

17   a display system via any connection devices (e.g., cables) or ports (e.g., video, etc.), where

18   the computer or display system serves as a host to process and accommodate plural users.

19   The target assembly may be utilized with one of a plurality of monitors displaying virtual

20   targets, while the other monitors are utilized to display information to third parties and/or the

21   user. The target assembly may be employed in conjunction with any conventional or other

22   range detection devices to determine a user range from the target assembly. The target

23   assembly may be utilized with the computer system and the display system, either

24   individually or in combination. The display and computer systems may determine and/or

25   display any desired session or other information.

26   The display system may include any quantity of any type of conventional or other

27   displays (e.g., LED, LCD, etc.) arranged in any fashion and displaying any desired

28   information. The displays may be of any size or shape. The processor may be implemented

29   by any conventional or other processor or circuitry to process coordinates and display

30   information on the displays. The processor may utilize any quantity of any type of counters

31   or timers, either software or hardware, to measure elapsed or any other time interval for a

1   session. The scoring may be set to any desired values for any zones within the target, where
2   the scoring may be determined in any conventional or other manner (e.g., sum, multiplication
3   or weighted, scaling factor, etc.).   The display system may include any quantity of
4   conventional or other switches or buttons of any shape or size, disposed at any locations and
5   serving as various controls (e.g., reset, user input, etc.). The computer and display systems
6   may receive power from any suitable source (e.g., batteries, common wall outlet jack, etc.).

7   It is to be understood that the software for the target assembly and computer and
8   display systems may be implemented in any desired computer language and could be
9   developed by one of ordinary skill in the computer arts based on the functional descriptions
10   contained in the specification and flow chart illustrated in the drawings. The various
11   functions of the target assembly can be distributed in any manner among any quantity of
12   software modules, processing systems and/or circuitry. The software and/or algorithms
13   described above and illustrated in the flow chart may be modified in any manner that
14   accomplishes the functions described herein.

15   The target assembly is not limited to the applications disclosed herein, but may be
16   utilized as a peripheral to enter information into any computer or processing system in
17   accordance with the location of the detection device identified by a user (e.g., the device may
18   be utilized for prompt or menu selections, for identifying impact locations on a target or other
19   object, for entry of data based on selections displayed, etc.). In addition, the target assembly
20   may be configured and utilized to detect impact locations for various objects (e.g., projectiles,
21   coins, balls (e.g., baseball, football, golf ball, tennis ball, etc.), weapons, rocks, marbles,
22   arrows, etc.) propelled in any fashion (e.g., by hand, mock firearm, sling-shot, bow, rubber
23   band, etc.) for use with training, simulation, gaming or other applications.

24   From the foregoing description, it will be appreciated that the invention makes
25   available a novel target system and method for ascertaining target impact locations of a
26   projectile propelled from a soft air type firearm, wherein a target system ascertains projectile
27   impact locations thereon and transfers the impact information to a computer system to
28   visually indicate the impact locations and/or interact with a gaming application.

29   Having described preferred embodiments of a new and improved target system and
30   method for ascertaining target impact locations of a projectile propelled from a soft air type
31   firearm, it is believed that other modifications, variations and changes will be suggested to

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1 those skilled in the art in view of the teachings set forth herein. It is therefore to be

2 understood that all such variations, modifications and changes are believed to fall within the

3 scope of the present invention as defined by the appended claims.